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Rune

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(54) **MOBILE TELECOMMUNICATIONS NETWORK AND METHOD FOR IMPLEMENTING AND IDENTIFYING HIERARCHICAL OVERLAPPING RADIO COVERAGE AREAS**

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(51) **Int. Cl.**^{7} **H04Q 7/20**

(52) **U.S. Cl.** **455/456**; 455/432; 455/449; 455/443

(58) **Field of Search** 455/432, 435, 455/443, 444, 446, 448, 449, 456, 422, 433, 445

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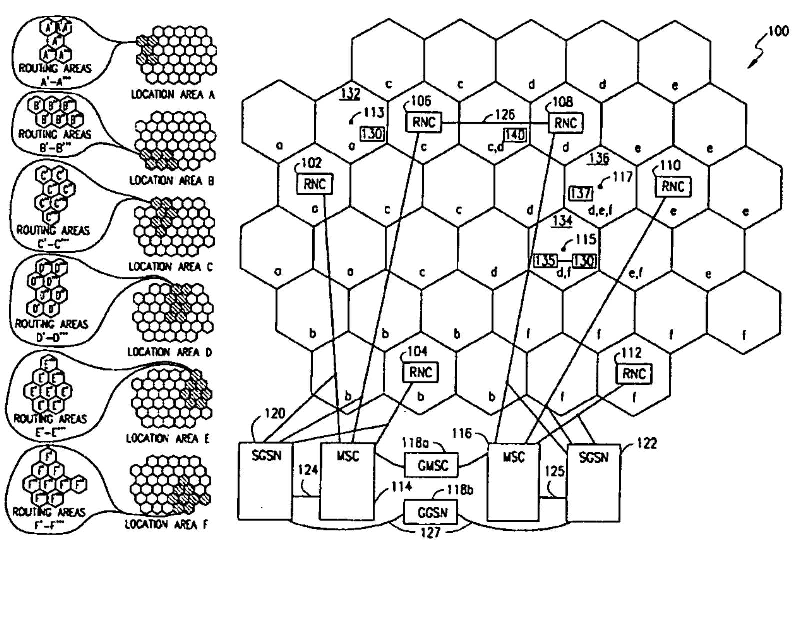
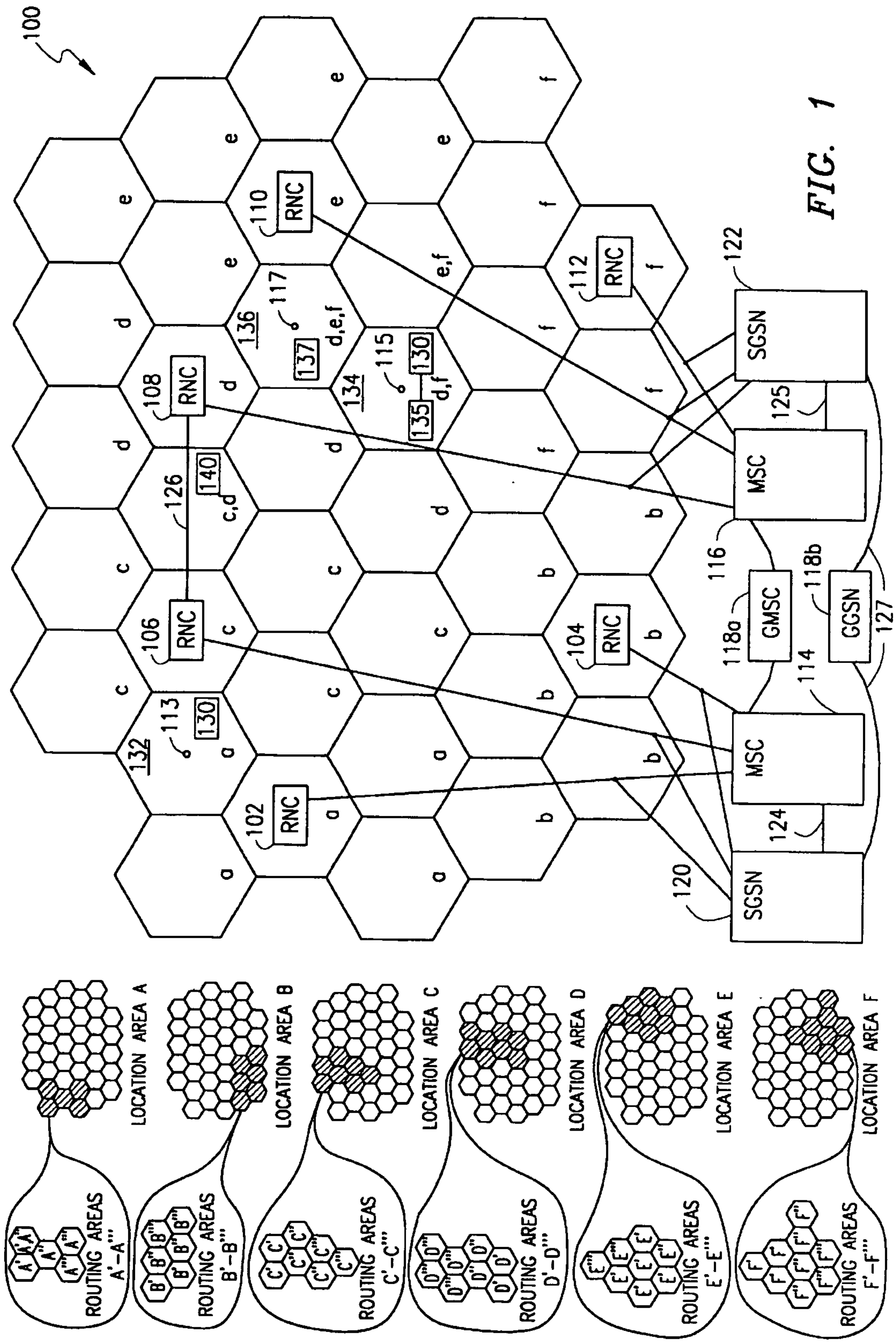
(57) **ABSTRACT**

A mobile telecommunications network and method for identifying hierarchical and overlapping radio coverage areas including a combination of at least one location area and at least one routing area. More specifically, the mobile telecommunications network includes a first switching center and a second switching center coupled to a controller that manages a plurality of location areas and a plurality of routing areas. The location areas and routing areas are also controlled by the first switching center and the second switching center, respectively. The mobile telecommunications network further includes a plurality of cells, where the cells accommodate at least one of the location areas and at least one of the routing areas. Lastly, the mobile telecommunications network further includes an identification system for identifying at least one combination identifier representative of the at least one location area and the at least one routing area accommodated by each cell.

86 Claims, 8 Drawing Sheets




100
RNC
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118a
118b
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125
126
127
130
132
134
135
136
137
140
MSC
SGSN
GMSC
GGSN
LOCATION AREA A
LOCATION AREA B
LOCATION AREA C
LOCATION AREA D
LOCATION AREA E
LOCATION AREA F
ROUTING AREAS A'-A''''
ROUTING AREAS B'-B''''
ROUTING AREAS C'-C''''
ROUTING AREAS D'-D''''
ROUTING AREAS E'-E''''
ROUTING AREAS F'-F''''

FIG. 1

Further in accordance with the present invention, there is provided a second embodiment of a method and mobile telecommunications network where a base transceiver station located in a cell operates to transmit a combined location code representative of at least one location area and a combined routing code representative of at least one routing area accommodated by the cell.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the method and apparatus of the present invention may be had by reference to the following detailed description when taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a diagram illustrating the general architecture of a mobile telecommunications network incorporating hierarchical overlapping location areas and routing areas in accordance with the present invention;

FIG. 2 is a diagram illustrating a first embodiment of an identification system used within the mobile telecommunications network shown in FIG. 1, where the identification system operates to identify a cell accommodating one location area and multiple routing areas;

FIG. 3 is a diagram illustrating the first embodiment of the identification system used within the mobile telecommunications network shown in FIG. 1, where the identification system operates to identify another cell accommodating multiple location areas and one routing area;

FIG. 4 is a diagram illustrating the first embodiment of the identification system used within the mobile telecommunications network shown in FIG. 1, where the identification system operates to identify yet another cell accommodating multiple location areas and multiple routing areas;

FIG. 5 is a diagram illustrating exemplary location updates and routing updates that may be initiated by a roaming mobile terminal and a mobile terminal being turned on;

FIG. 6 is a diagram illustrating exemplary service areas (e.g., one or more routing areas) incorporating service area flags used in conjunction with a known temporary logical link identity (TLLI) feature;

FIG. 7 is a diagram illustrating a second embodiment of the identification system for identifying hierarchical overlapping location areas; and

FIG. 8 is a diagram illustrating the second embodiment of the identification system for identifying hierarchial overlapping routing areas.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring to the Drawings, wherein like numerals represent like parts throughout FIGS. 1–8, there are disclosed two embodiments of an exemplary mobile telecommunications network 100 in accordance with the present invention.

Although the mobile telecommunications network 100 will be discussed with reference to third generation standards (e.g., Universal Mobile Telecommunications System (UMTS) and International Mobile Telecommunications 2000 (IMT-2000)) incorporating an overlapping feature based on the PDC standard and a hierarchical location area structures feature based on the GSM/GPRS standards, those skilled in the art will appreciate that other standards and specifications may also utilize the principles of the present invention. Accordingly, the mobile telecommunications network 100 described should not be construed in such a limited manner.

In order to better describe the present invention, detailed descriptions about the specifics of the two embodiments associated with the identification of hierarchical overlapping location areas and routing areas within the mobile telecommunications network **100** are deferred pending a discussion about the architecture of hierarchical overlapping location and routing areas forming the mobile telecommunications network.

Referring to FIG. **1**, there is a diagram illustrating the architecture of the mobile telecommunications network **100** incorporating hierarchical overlapping location areas and routing areas in accordance with the present invention. It should be noted that the illustrated configuration of the mobile telecommunications network **100** is only one of many possible configurations that may form the mobile telecommunications network.

For example, there need not be a one-to-one relationship between controllers, mobile switching centers, base transceiver stations, location areas and routing areas as described below. Instead, there may be several location/routing areas served by one controller, and a single location/routing area may include cells that are controlled by more than one controller. The same relationship could be true for mobile switching centers and location/routing areas. In fact, some mobile telecommunications networks do not have controllers and, as such, directly connect the base transceiver stations to the mobile switching centers.

The mobile telecommunications network **100** can use either or both of a plurality of contiguous location areas A–C and overlapping location areas D–F for handling circuit switched calls within a particular geographic area. Each location area A–F includes the group of cells a–f and a radio network controller (RNC) **102, 104, 106, 108, 110** and **112**, respectively. The RNCs **102, 104, 106, 108, 110** and **112** in addition to being similar to known base station controllers may interface with one another by way of line **126** (only one shown).

As an illustration, the RNC **102** provides mobile service and manages the location area A and cells a, while the RNC **110** provides mobile service and manages the location area E and cells e. Each cell a–f includes a base transceiver station (BTS) **113, 115** and **117** (only three are shown) for transmitting and receiving mobile telecommunications preferably using mobility management and call control protocols similar to ones defined in the GSM standard. In addition, the RNCs **102, 104, 106, 108, 110** and **112** and BTSs **113, 115** and **117** are collectively referred to as a radio access network (RAN) which generally has responsibility for radio related functions.

A number of the RNCs **102, 104, 106, 108, 110** and **112** can be associated with any number of mobile switching centers (MSCs) **114** and **116**. As an illustration, the RNCs **102, 104** and **106** can be controlled by the MSC **114**, and the RNCs **108, 110** and **112** may be controlled by the MSC **116**. The MSCs **114** and **116** are, in turn, connected to a gateway mobile switching center (GMSC) **118***a*, which generally functions as an interface between the mobile telecommunications network **100** and, for example, a public switched telephone network (PSTN) (not shown).

In addition to the location areas A–F used in handling circuit switched calls, the mobile telecommunications network **100** can incorporate either or both of a plurality of a contiguous routing areas A'–A'", B'–B'" and C'–C'" and overlapping routing areas D'–D'", E'–E'" and F'–F'" for handling packet switched data calls. The routing areas A'–F'" represent a lower hierarchical level as compared to a higher hierarchical level represented by the location areas A–F. Each routing area A'–F'" may be accommodated by at least

one of the cells a–f and managed by one of the RNCs **102**, **104**, **106**, **108**, **110** or **112** in a similar manner as mentioned above with respect to the location areas A–F. It should be understood that any one of the cells a–f can accommodate a combination of one or more location areas and routing areas A'–F'".

Each of the RNCs **102**, **104**, **106**, **108**, **110** and **112** connect to a serving general packet radio service support node (SGSNs) **120** and **122** (two shown) that control a service area including one or more routing areas. As an illustration, the RNCs **102**, **104** and **106** can be controlled by the SGSN **120** that manages the service area including routing areas A'–C'", and the RNCs **108**, **110** and **112** may be controlled by the SGSN **122** that manages another service area including routing areas D'–F'". The SGSNs **120** and **122** are, in turn, connected by way of lines **127** to a GGSN **118b** (Gateway GPRS Support Node). It should be understood that a routing area may well cross a SGSN service area border to permit routing area overlapping around the SGSN service area borders.

The SGSNs **120** and **122**, MSCs **114** and **116** and GMSC **118a** and GGSN **118b** are collectively known as a core network which has the responsibility for functions including, for example, mobility management, call control, supplementary services and charging. In addition, the SGSNs **120** and **122** may interface with the MSCs **114** and **116** by way of lines **124** and **126**, respectively.

Referring to FIGS. **2–8**, there are illustrated the first embodiment (FIGS. **2–6**) and the second embodiment (FIGS. **7–8**) associated with identifying hierarchical overlapping location areas and routing areas within the mobile telecommunications network **100**. The identification of hierarchical overlapping location areas and routing areas and subsequent transmitting of corresponding identifiers (described later) enables a mobile terminal **130** (FIG. **1**) to keep track of which location area and/or routing areas it is presently registered to operate within by comparing the transmitted identifiers with stored identifiers. And, if there is no match then a location update and/or a routing update is initiated by the mobile terminal **130** to register with a newly entered location area or routing area. Generally, the mobile telecommunications network **100** is informed whenever the mobile terminal **130** changes location area or routing area so that the mobile telecommunications network can forward incoming traffic to the mobile terminal.

Referring to FIG. **2**, there is illustrated an identification system **200** of the first embodiment used to identify a cell accommodating one location area and two routing areas. As an illustration, a cell **132** (FIG. **1**) accommodating the location area A and two of the routing areas A' and A" is described. The base transceiver station (BTS) **113** located in cell **132** operates to broadcast to the mobile terminal **130** a unique location area identifier (LAI-A) **202** associated with the location area A. The same LAI-A **202** is broadcast by all of the BTSs located in the cells accommodating the location area A. In addition, the BTS **113** also broadcasts a routing area identifier RAI-A'A **208** associated with the routing area A', and a second routing area identifier RAI-A"A **210** associated with the routing area A". Generally, the routing area identifiers RAI-A' and RAI-A" are only unique within the scope of the location area representing the higher hierarchical level.

Thereafter, the mobile terminal **130** and network **100** each form a first combination identifier **204** and a second combination identifier **206**. The first combination identifier **204** includes the LAI-A **202** coupled with a first routing area identifier (RAI-A'A) **208**. And, the second combination identifier **206** includes the LAI-A **202** coupled with a second routing identifier (RAI-A'A) **210**. Likewise, the mobile terminal **130** and network **100** each assign a location number **212** for use instead of the LAI-A **202** and two combination numbers **214** and **216** for use instead of the two combination identifiers **204** and **206**, respectively. The location number **212**, first combination number **214** and the second combination number **216** are shorter than their corresponding identifiers **202**, **204** and **206** and as such are more efficient to handle than the entire string of bits associated with the corresponding identifiers.

It should be understood that the combination numbers and location numbers are not used by the mobile terminal **130** during a location or routing update, because the mobile terminal has to indicate the location identifier and routing identifier in another cell where the previous location or routing update was performed. On the other hand, the combination number can be used to make a temporary identity unique within a border cell since the mobile terminal was assigned its temporary identity in a location area and routing area whose identities are included in the broadcast system information present in the cell.

Referring to FIG. **3**, there is illustrated the identification system **200** of the first embodiment used to identify a cell accommodating two location areas and one routing area. As an illustration, a cell **134** (FIG. **1**) accommodating the location areas D and F and the routing area D' is described.

The BTS **115** located in cell **134** operates to broadcast to the mobile terminal **135** unique location area identifiers LAI-D **302** associated with the location area D and LAI-F **304** associated with the location area F. The same LAI-D **302** and LAI-F **304** are broadcast by all of the BTSs located in the cells accommodating the location areas D and F. In addition, the BTS **115** also transmits two routing area identifiers RAD-D'D **310** and RAI-D'F **312**, both associated with the routing area D'.

Thereafter, the mobile terminal **135** and network **100** each form a first combination identifier **306** and a second combination identifier **308** which are not to be confused with the combination identifiers **204** and **206** described in FIG. **2**. The first combination identifier **306** includes the LAI-D **302** coupled with a first routing area identifier (RAI-D'D) **310**. And, the second combination identifier **308** includes the LAI-F **304** coupled with a second routing area identifier (RAI-D'F) **312**. Likewise, the mobile terminal **135** and network **100** each assign a first location number **314** and a second location number **316** for use instead of the LAI-D **302** and LAI-F **304** and two combination numbers **318** and **320** for use instead of the two combination identifiers **306** and **308**, respectively. Again, the first location number **314**, second location number **316**, first combination number **318** and the second combination number **320** are shorter than their corresponding identifiers **302**, **304**, **306** and **308** and as such are more efficient to handle than the entire string of bits associated with the corresponding identifiers. The first and second location numbers **314** and **316** and the first and second combination numbers **318** and **320** are not to be confused the location number **212** and combination numbers **214** and **216** described with reference to FIG. **2**.

Referring to FIG. **4**, there is illustrated the identification system **200** of the first embodiment used to identify a cell accommodating three location areas and three routing areas. As an illustration, a cell **136** (FIG. **1**) accommodating the location areas D, E and F and the routing areas D",E' and F is described.